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A MOISTURE TESTER USING EXHAUST HEAT[1/]

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The ability to determine moisture in soil and crops is essential to successful farming. Moisture in the soil influences cultivation of the field, seeding of the crop, sprouting of the seed, and growth of the plants. Moisture in the crop influences the time it should be cut for forage or windrowed for quality seed. Moisture in the seed can be used as an indicator of maturity, of time to mow, and of time to combine the crop. Moisture in fibers such as cotton, flax, ramie, jute, and hemp affects their strength, serves as an indicator of maturity, and influences the processing, storage, and marketing of the fibers. Moisture in stored hay can cause spontaneous combustion and lead to destructive fires.

Moisture content also influences the handling, drying, processing, storing, and marketing of seed. Seed moisture materially affects the length of time and the temperature at which seed can be stored without losing its viability. High moisture in seeds often causes heating and loss of seed viability.

Agricultural engineers of the U.S. Department of Agriculture, Agricultural Research Service, working in cooperation with the Oregon Agricultural Experiment Station at Corvallis, Oregon, have developed a moisture tester that is simple and inexpensive; as the source of drying heat it uses the exhaust of a truck, tractor, automobile, or other internal combustion engine. Also developed was a procedure that uses this tester to determine moisture content of any material that can be inserted into the drying chamber and held there between screens.

The moisture tester components are light, are easily transported from one location to another, and require only a few minutes to set up. On most products, a moisture percentage reading can be made within 15 minutes. The moisture determination can be read directly on the wet basis and involves no calculations or corrections for temperature.

1/ The original idea for using exhaust heat for drying material came from: Dexter, S. T., "A Method for Rapidly Determining the Moisture Content of Hay or Grain." Mich. Agr. Exp. Sta. Quart. Bul. 30, pp. 158-166, 1947.

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Research engineers have used the tester for two years to determine seed moisture in a time-of-harvest study of grass and legumes. Drying time varied from 6 to 10 minutes, and the moisture of the material ranged from 5 percent to 65 percent. Throughout the range, moisture readings varied less than 2 percent from the moisture readings obtained in the laboratory using the standard electric oven and 24-hour drying procedure.

The moisture tester consists of a dietary balance, a 0° to 300° F. mercury thermometer, a sample container with screens on top and bottom, an adapter, and a base stand equipped with a flexible metal pipe to facilitate connecting the unit to an exhaust pipe. Figure 1 shows the moisture tester connected to an Agricultural Research Service truck and being used to dry a sample of orchardgrass seed. While a mercury glass thermometer is shown in the figure, a steel tube dial type thermometer is preferable due to its greater durability.

The drying unit can be fabricated easily in any sheet-metal shop. The hose used to connect the exhaust pipe and the drying chamber is a flexible exhaust pipe that is available from automobile supply companies. Figure 2 gives the dimensions and identification of parts. The glass thermometer and the dietary balance are available from hardware stores or scientific supply companies. The face of the balance was altered by covering the gram numerals with a face that has three scales, each with a different length and background color as shown in figure 3. The scale lengths correspond to 0 to 50, 0 to 100, and 0 to 200 gram lengths, respectively, with each being divided into equally-spaced sections corresponding to the moisture percentage.

The procedure used in making a seed moisture determination using the exhaust moisture tester is as follows: Collect a representative sample by stripping the seed heads from the straw as shown in figure 4. Place the empty sample container, adapter, and screened cap on the dietary balance and rotate the balance face until the pointer rests directly on 100 percent, which is common to all three scales. Each scale will accommodate a different range of material density, making the balance usable over a wide span.

Fill the container with the seed to be tested until the pointer reaches zero on one of the three scales. The scale to be used will be determined by

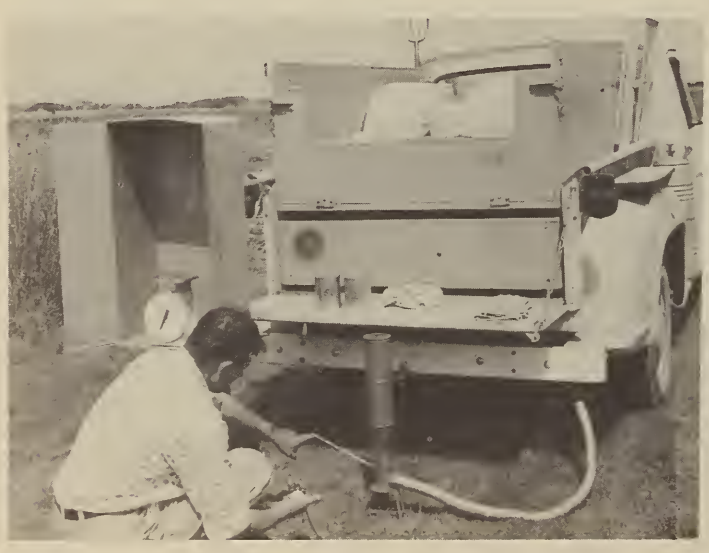

Figure 1. Moisture tester connected to ARS truck and being used to dry a sample of orchardgrass seed.

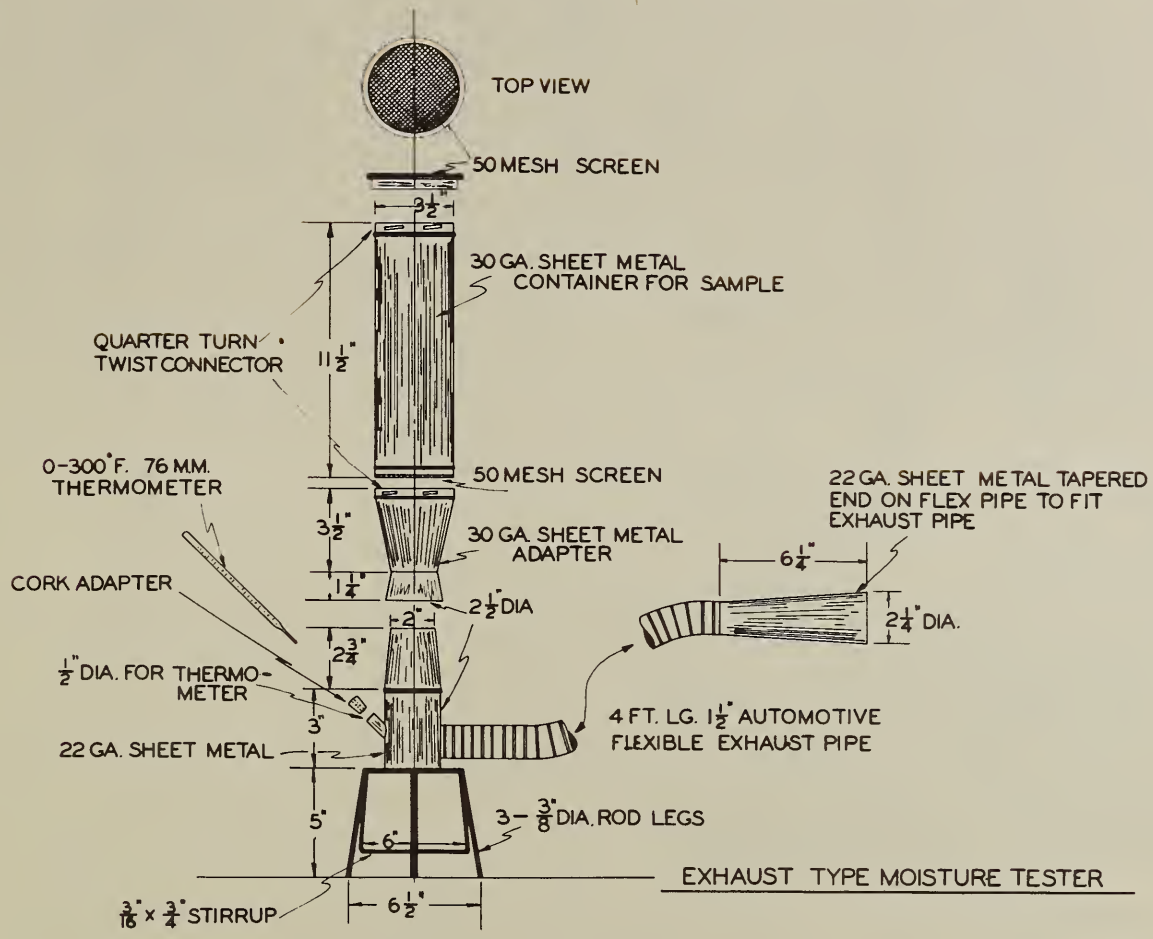

Figure 2. Drawing of exhaust type moisture tester, showing parts and dimensions.

Figure 3. Dietary scale which has been altered to read the moisture directly.

the density of the material. Use whichever scale will allow the maximum possible quantity in the container. Connect the flexible metal pipe and base stand assembly to the exhaust pipe and run the engine at a speed to give a temperature of 300° F. on the thermometer. The faster the engine is run, the higher the temperature will be. Place the capped sample container with sample on the base stand and dry for 4 minutes.

Using a pair of asbestos gloves, replace the container on the balance. Note the moisture percentage indicated by the pointer on the scale originally selected. Return the container to the base stand and dry another 2 minutes. Repeat the weighing. If the pointer indicates the same reading as at the end of 4 minutes, the sample is dry.

Figure 4. Collecting a representative sample by stripping the seed heads from the straw.

Some materials require a longer drying time than others, so repeat the drying and weighing until two weighings are identical.

Recommended procedures to increase the accuracy of the test are as follows:

1. Bring the container up to temperature before weighing it and before adding the sample, so that surface moisture variations will be minimized.

2. Make sure that the container is in the center of the balance while weighing.

3. Tap the balance pan before taking a reading. Repeat a second and third time and take readings; then use the average of these 3 readings for the moisture percentage.

4. Run the engine until warm to evaporate any moisture in the exhaust system.

5. If the seed under test is such that it will not liberate moisture readily due to size of the seed or nature of the seed coat, cracking or crushing of the seed may be required.

The same procedure can be used to economically determine the moisture content of any product that can be placed in the container and that can be confined by the screens. It is ideal for on-the-spot moisture testing in farming, processing, and manufacturing.